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## Effect of different micronutrients and stage of their application on growth of cauliflower (*Brassica Oleracea* var. *botrytis*)

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### Abstract

A field experiment was conducted at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Gujarat in the *rabi* season of the year 2017-18 to study the effect of different micronutrients and stage of their application on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*). The experiment was laid out in Randomized Block Design with Factorial concept comprising of two factors. The first factor was stages of micronutrient application (S) *i.e.* s<sub>1</sub> - at seedling stage (15 DAS), s<sub>2</sub> - after transplanting (20 & 35 DAT) and s<sub>3</sub> - at seedling stage (15 DAS) and after transplanting (20 & 35 DAT) and the second factor was micronutrients with eight levels *viz.*, m<sub>0</sub> - Zn 0 ppm + B 0 ppm + Mo 0 ppm, m<sub>1</sub> - Zn 0 ppm + B 0 ppm + Mo 50 ppm, m<sub>2</sub> - Zn 0 ppm + B 200 ppm + Mo 0 ppm, m<sub>3</sub> - Zn 0 ppm + B 200 ppm + Mo 50 ppm, m<sub>4</sub> - Zn 1000 ppm + B 0 ppm + Mo 0 ppm, m<sub>5</sub> - Zn 1000 ppm + B 0 ppm + Mo 50 ppm, m<sub>6</sub> - Zn 1000 ppm + B 200 ppm + Mo 0 ppm, m<sub>7</sub> - Zn 1000 ppm + B 200 ppm + Mo 50 ppm. The treatments were replicated thrice. The individual effect of micronutrient application at different stages as well as their interaction effect on growth and quality of cauliflower cv. 'Pusa Snowball K 1' was recorded. The results indicate that micronutrient application at seedling stage (15 DAS) and after transplanting (20 & 35 DAT) gave maximum plant height at 20, 35 DAT and at harvest, leaf area at 45 DAT and a, b & total chlorophyll at 45 DAT. Higher dose of micronutrient application was found *i.e.* @ Zn 1000 ppm + B 200 ppm + Mo 50 ppm superior for growth parameters *i.e.* plant height at 20, 35 DAT and at harvest, leaf area at 45 DAT and a, b & total chlorophyll at 45 DAT. The interaction effect of stage of micronutrient application and micronutrients were found not significant for all parameters of growth and quality. Thus from the present investigation it could be concluded that for successful cultivation of cauliflower, micronutrient should spray at seedling stage (15 DAS) and 20 & 35 DAT for getting better growth. Micronutrients should applied @ Zn 1000 ppm + B 200 ppm + Mo 50 ppm for same.

**Keywords:** Cauliflower, micronutrients, growth

### Introduction

Cauliflower is one of several vegetable in the species *Brassica oleracea* L., in the family Brassicaceae. It is an annual plant that reproduces by seed. The edible part, *i.e.* curd is a 'Pre-floral fleshy apical meristem' and it is generally white in colour and may be enclosed by inner leaves before its exposure (Sitapara *et al.* 2011) [12]. Typically, only the white curd of aborted floral meristem is eaten, while the stalk and surrounding thick, green leaves are used in vegetable broth or discarded. Its name is from Latin *caulis* (cabbage) and flower, an acknowledgment of its unusual place among a family of food plants which normally produce only leafy greens for eating.

The nutrient elements which are required comparatively in small quantities are called as micro or minor nutrients or trace elements. Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. The requirements of micronutrients (boron, iron, copper, zinc, manganese, chloride and molybdenum) are only in traces, which are partly met from the soil or through chemical fertilizer or through other sources (Chaudhari *et al.* 2017) [2].

Cauliflower suffers widely by Boron and Molybdenum deficiency followed by Zinc, Manganese, Copper and Iron deficiencies. Cl, Cu, Fe and Mn are involved in various

processes related to photosynthesis and Zn, Cu, Fe, and Mn are associated with various enzyme systems; Mo is specific for nitrate reductase only. B is the only micronutrient not specifically associated with either photosynthesis or enzyme function, but it is associated with the carbohydrate chemistry and reproductive system of the plant. The cauliflower crop often shows the deficiency symptoms of boron and molybdenum as browning of curd and whiptail formation of leaves respectively. These disorders render curds unfit for human consumption and reduce the curd yield considerably (Singh and Thakur 1991) [8].

Zinc is essential component of many enzymes such as carbonic anhydrase, alcohol dehydrogenase, superoxide dismutase and RNA polymerase etc. and also involved in nitrogen metabolism. It plays role in synthesis of plant growth substances and enzyme systems and is essential for promoting certain metabolic reactions. It is necessary for production of chlorophyll and carbohydrates.

Boron is an essential plant micronutrient for a constituent of cell membrane and essential for cell division. It is also concerned with the precipitation of excess cation, buffer action, maintenance of conducting tissues and help in absorption of nitrogen. Boron also affect the cambial and phloem tissues of storage root or stem apical meristem and leaves, vascular cambia of fruits and other organs which are capable of meristematic activities (Singh, 1991) [8, 9]. Boron significantly improves the vegetative growth and quantitative parameters of cole crops (Singh *et al.* 2003) [11]. In cauliflower boron deficiency has been reported very frequently. Till the curd start developing, external symptoms of boron deficiency are not very apparent in most cases. In more advanced stages, pinkish or rusty brown areas develop on the surface of curd and hence, it is called brown rot or red rot and these types of curds develop bitter taste, which reduces the marketable quality of curd.

Molybdenum is also very essential micronutrient for the better growth and development. It is an essential component of major enzyme nitrate reductase in the plant. It occurs in envelopes of chloroplast in leaves. As a Result the leaf blade fails to develop properly and only the midrib portions develop resulting sword like appearance of leaves giving whiptail symptom. (Singh *et al.* 2017) [10].

## Materials and Methods

The experiment was carried out in open field condition during *rabi* season, 2017-18 at field of College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. - Mehsana (Gujarat).

Variety Pusa Snowball k 1 of cauliflower was taken under investigation, the seeds of this variety were procured from IARI, Regional Station, Katrain (Kullu Valley).

Micronutrients were the commercial preparation available in the market and it was in powder form. The application of zinc, boron and molybdenum as foliar spray of zinc sulphate, borax and ammonium molybdate, respectively was used and sprayed on foliage in aqueous form by using fresh solution at each spray. For preparation of 1000 ppm Zn, 200 ppm B and 50 ppm Mo weighed 4.76 g of zinc sulphate hepta hydrate, 1.82 g borax and 0.1 g ammonium molybdate, respectively dissolved separately in one litre water. Spraying was done with micro sprayer and the leaves were wetted thoroughly with a fine mist.

The experiment was laid out in Randomized Block Design with factorial concept (FRBD) keeping two factors *viz.*, stage of application of micronutrients and micronutrients, the first

factor with three stage of application of micronutrients *i.e.* at seedling stage (15 DAS), after transplanting (20 & 35 DAT), at seedling stage (15 DAS) and after transplanting (20 & 35 DAT) while second factor *i.e.* micronutrients with eight levels thus, making twenty four treatment combinations.

## Plant height at 20, 35 DAT and at harvest (cm)

The plant height was measured in cm from the ground level to top of the plant after 20, 35 days from the date of transplanting and at harvest with the help of meter scale and average of five tagged plants was calculated.

## Leaf area at 45 DAT

At 45 DAT five randomly selected large, medium and small leaves of five tagged plants were used to calculate the leaf area (cm<sup>2</sup>) per plant and average was work out. It was measured with the help of leaf area meter (Systronics, leaf area meter 211).

## Estimation of a, b & total chlorophyll at 45 DAT

The leaves of selected plants analysed for estimation of a, b and total chlorophyll (mg/100g) as per method suggested by Sadasivam and Manickam (1997) [7].

## Results and Discussion

### Growth Parameters

#### Effect of stage of micronutrient application and micronutrients on plant height at 20, 35 DAT and at harvest

Effect of stage of micronutrient application and micronutrients on plant height at 20, 35 DAT and at harvest is presented in Table 1.

Maximum plant height at 20 DAT (20.57 cm), 35 DAT (27.49 cm) and at harvest (45.57 cm) were recorded with application of micronutrients at seedling stage and after transplanting (s<sub>3</sub>), which was at par with treatment s<sub>2</sub>. It was found that plant height showed better results by the foliar application of micronutrient mixture two times than the single foliar application. It may be due to getting the sufficient amount of these nutrients stimulated enzymatic activities, leading to an improvement in biochemical process like photosynthesis, respiration and protein synthesis.

Micronutrients involves in different physiological process like enzyme activation, electron transport, chlorophyll formation and stomatal regulation *etc.* These results were in conformity with the findings of Mehraj *et al.* (2015) [5] in okra.

Significantly maximum plant height at 20 DAT (24.01 cm), 35 DAT (30.56 cm) and at harvest (47.89 cm) were observed with application of Zn 1000 ppm + B 200 ppm + Mo 50 ppm (m<sub>7</sub>).

Increase plant height by application of micronutrients may be due to zinc is directly involving in photosynthesis and play vital role in shoot production, Boron plays major role in synthesis of cell wall, occurrence of cell division, transportation of carbohydrates and hormone activation that helping in the root and shoots growth of the plant. The similar results were also reported with the application of micronutrient through foliar sprays by Ain *et al.* (2016) [1] in broccoli. It could be revealed that, the combined foliar application of different micronutrients might have accelerated the rate of metabolic activities in the plant system that might have resulted in increasing height of the plant. The similar results were also reported with the application of micronutrient mixture through foliar sprays by Patel (2002) [6],

Jamre and Verma (2010)<sup>[3]</sup> and Chaudhari *et al.* (2017)<sup>[2]</sup> in cauliflower.

Close review of data presented in Table 1 exhibited the not significant results of combined effect of stages of micronutrient application and micronutrients at harvest.

### Effect of stage of micronutrient application and micronutrients on chlorophyll a, b and total chlorophyll (mg/g) at 45 DAT

Data revealed that the influence of different stage of

micronutrient application with respect to chlorophyll a (mg/g) at 45 DAT was found significant. Significantly maximum chlorophyll a (1.24 mg/g), chlorophyll b (0.85 mg/g) and total chlorophyll (2.21 mg/g) at 45 DAT were found with application of micronutrient at seedling stage and after transplanting (s<sub>3</sub>). Micronutrients involves in different physiological process like enzyme activation, electron transport, chlorophyll formation and stomatal regulation *etc.* These results were in conformity with the results of Mehraj *et al.* (2015)<sup>[5]</sup> in okra.

**Table 1:** Effect of stage of micronutrient application and micronutrients on plant height (cm) at 20, 35 DAT and at harvest

Micronutrients (M) (ppm)	Plant height (cm) at 20 DAT				Plant height (cm) at 35 DAT				Plant height (cm) at harvest			
	Stage of micronutrient application (S)			Mean	Stage of micronutrient application (S)			Mean	Stage of micronutrient application (S)			Mean
	(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )		(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )		(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )	
m <sub>0</sub> : Zn 0+ B 0 + Mo 0	16.78	16.47	17.13	16.79	23.58	23.98	25.98	24.51	39.74	40.15	42.26	40.72
m <sub>1</sub> : Zn 0 + B 0 + Mo 50	17.40	17.34	18.37	17.71	23.98	24.88	24.51	24.46	39.92	41.55	43.11	41.53
m <sub>2</sub> : Zn 0 + B 200 + Mo 0	17.56	17.70	19.40	18.22	24.48	25.31	25.51	25.10	42.89	42.30	43.49	42.89
m <sub>3</sub> : Zn 0 + B 200 + Mo 50	18.41	19.18	20.37	19.32	25.38	25.71	26.58	25.89	41.95	43.10	44.72	43.25
m <sub>4</sub> : Zn 1000 + B 0 + Mo 0	19.35	20.00	20.16	19.84	26.11	26.31	26.98	26.47	43.83	43.65	45.13	44.20
m <sub>5</sub> : Zn 1000 + B 0 + Mo 50	20.27	20.82	22.02	21.04	27.11	27.11	28.25	27.49	44.83	44.34	47.01	45.39
m <sub>6</sub> : Zn 1000 + B 200 + Mo 0	21.74	22.34	23.13	22.40	27.71	28.18	29.98	28.62	45.61	45.41	48.83	46.62
m <sub>7</sub> : Zn 1000 + B 200 + Mo 50	23.60	24.44	24.00	24.01	29.51	30.05	32.11	30.56	45.47	48.17	50.02	47.89
Mean	19.39	19.79	20.57		25.98	26.44	27.49		43.03	43.58	45.57	
	S	M	Interaction (S x M)		S	M	Interaction (S x M)		S	M	Interaction (S x M)	
S.Em.±	0.32	0.53	0.92		0.38	0.63	1.08		0.73	1.19	2.06	
C.D. at 5%	0.92	1.51	NS		1.09	1.78	NS		2.08	3.39	NS	
C. V. (%)	7.98				7.05				8.11			

**Note:** S: Stage of application of micronutrients, M: Micronutrients, s<sub>1</sub>: At seedling stage (15 DAS), s<sub>2</sub>: After transplanting (20 & 35 DAT), s<sub>3</sub>: At seedling stage (15 DAS) and after transplanting (20 & 35 DAT).

**Table 2:** Effect of stage of micronutrient application and micronutrients on a, b and total chlorophyll (mg/g) at 45 DAT

Micronutrients (M) (ppm)	Chlorophyll a (mg/g) at 45 DAT				Chlorophyll b(mg/g) at 45 DAT				Total chlorophyll (mg/g) at 45 DAT			
	Stage of micronutrient application (S)			Mean	Stage of micronutrient application (S)			Mean	Stage of micronutrient application (S)			Mean
	(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )		(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )		(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )	
m <sub>0</sub> : Zn 0+ B 0 + Mo 0	0.64	0.62	0.77	0.68	0.45	0.51	0.41	0.46	1.03	1.13	1.24	1.13
m <sub>1</sub> : Zn 0 + B 0 + Mo 50	0.77	0.72	0.89	0.79	0.51	0.55	0.56	0.54	1.19	1.31	1.53	1.34
m <sub>2</sub> : Zn 0 + B 200 + Mo 0	0.81	0.91	1.01	0.91	0.57	0.63	0.62	0.60	1.44	1.43	1.72	1.53
m <sub>3</sub> : Zn 0 + B 200 + Mo 50	0.93	0.99	1.04	0.99	0.71	0.67	0.74	0.71	1.65	1.61	1.87	1.71
m <sub>4</sub> : Zn 1000 + B 0 + Mo 0	0.95	0.98	1.17	1.04	0.85	0.79	0.94	0.86	1.77	1.76	2.23	1.92
m <sub>5</sub> : Zn 1000 + B 0 + Mo 50	1.23	1.22	1.52	1.32	0.92	0.91	1.14	0.99	2.09	2.17	2.75	2.34
m <sub>6</sub> : Zn 1000 + B 200 + Mo 0	1.33	1.45	1.63	1.47	1.09	1.19	1.11	1.13	2.47	2.48	2.93	2.63
m <sub>7</sub> : Zn 1000 + B 200 + Mo 50	2.01	2.13	1.90	2.01	1.08	1.13	1.26	1.16	3.20	3.10	3.38	3.23
Mean	1.08	1.13	1.24		0.77	0.80	0.85		1.86	1.87	2.21	
	S	M	Interaction (S x M)		S	M	Interaction (S x M)		S	M	Interaction (S x M)	
S.Em.±	0.02	0.04	0.07		0.02	0.03	0.05		0.04	0.07	0.11	
C.D. at 5%	0.07	0.11	NS		0.05	0.08	NS		0.11	0.19	NS	
C. V. (%)	9.88				10.62				9.93			

**Note:** S: Stage of application of micronutrients, M: Micronutrients, s<sub>1</sub>: At seedling stage (15 DAS), s<sub>2</sub>: After transplanting (20 & 35 DAT), s<sub>3</sub>: At seedling stage (15 DAS) and after transplanting (20 & 35 DAT).

Significantly maximum chlorophyll a (2.01 mg/g), chlorophyll b (1.16 mg/g) and total chlorophyll (3.23 mg/g) at 45 DAT were recorded with application of Zn 1000 ppm + B 200 ppm + Mo 50 ppm treatment (m<sub>7</sub>). The significantly minimum chlorophyll a (0.68 mg/g) at 45 DAT was found without micronutrients application (m<sub>0</sub>).

The increase in the values of chlorophyll content may be due to the availability of zinc which aids plant growth hormone and enzyme system, hence it is necessary for chlorophyll formation likewise iron acts as an oxygen carrier and involved

in cell division and growth which might have promotes chlorophyll formation.

The similar results were also reported by Kotecha *et al.* (2011)<sup>[4]</sup> who reported that, the combined application of zinc sulphate 0.5% and gibberlic acid 100 ppm were found effective in increasing chlorophyll content in cabbage.

The interaction between different stage of micronutrient application and micronutrients exhibited not significant difference with respect to chlorophyll a, b and total chlorophyll at 45 DAT.

### Effect of stage of micronutrient application and micronutrients on leaf area (cm<sup>2</sup>) at 45 DAT

Data showed that individual effect of stage of micronutrient application and micronutrients was found significant, whereas interaction of both was found not significant.

Data mentioned in Table 3 revealed that the influence of different stage of micronutrient application with respect to leaf area was found significant. Significantly maximum leaf area (1023.71 cm<sup>2</sup>) at 45 DAT was found with application of micronutrient at seedling stage and after transplanting (s<sub>3</sub>), whereas minimum leaf area (840.02 cm<sup>2</sup>) was observed at application of micronutrient at seedling stage (s<sub>1</sub>). Micronutrients involves in different physiological process like enzyme activation, electron transport, chlorophyll formation and stomatal regulation etc. These results were in conformity

with the results of Mehraj *et al.* (2015) [5].

Significantly maximum leaf area (1140.29 cm<sup>2</sup>) at 45 DAT was recorded with application of Zn 1000 ppm + B 200 ppm + Mo 50 ppm treatment (m<sub>7</sub>). Minimum leaf area (870.36 cm<sup>2</sup>) at 45 DAT was found in treatment no application of micronutrients.

Increase in leaf area may be due to combined application of Zn, B and Mo that accelerate photosynthesis process and enhances translocation of metabolites then development as well as elongation of new cells. These finding are accordance with earlier reported by Patel (2002) [6] in cauliflower and Kotecha *et al.* (2011) [4] in cabbage.

Closer view of the data shows that the interaction between stage of micronutrient application and micronutrients could not exerted any significant effect on leaf area at 45 DAT.

**Table 3:** Effect of stage of micronutrient application and micronutrients on leaf area (cm<sup>2</sup>) at 45 DAT

Micronutrients (M) (ppm)	Leaf area(cm <sup>2</sup> ) at 45 DAT			
	Stage of micronutrient application (S)			Mean
	(s <sub>1</sub> )	(s <sub>2</sub> )	(s <sub>3</sub> )	
m <sub>0</sub> : Zn 0+ B 0 + Mo 0	711.98	917.14	981.96	870.36
m <sub>1</sub> :Zn 0 + B 0 + Mo 50	725.05	917.84	981.45	874.78
m <sub>2</sub> : Zn 0 + B 200 + Mo 0	787.86	808.05	945.53	847.15
m <sub>3</sub> : Zn 0 + B 200 + Mo 50	809.60	921.85	930.16	887.20
m <sub>4</sub> : Zn 1000 + B 0 + Mo 0	807.50	925.11	966.80	899.80
m <sub>5</sub> : Zn 1000 + B 0 + Mo 50	883.78	900.24	1035.39	939.80
m <sub>6</sub> : Zn 1000 + B 200 + Mo 0	950.14	1046.90	1121.31	1039.45
m <sub>7</sub> : Zn 1000 + B 200 + Mo 50	1044.25	1149.56	1227.06	1140.29
Mean	840.02	948.34	1023.71	
	Stage of application (S)	Micronutrient (M)	Interaction (S x M)	
S.Em.±	13.43	21.93	37.99	
C.D. at 5%	38.24	62.44	NS	
C. V. (%)	7.02			

**Note:** S: Stage of application of micronutrients, M: Micronutrients, s<sub>1</sub>: At seedling stage (15 DAS), s<sub>2</sub>: After transplanting (20 & 35 DAT), s<sub>3</sub>: At seedling stage (15 DAS) and after transplanting (20 & 35 DAT).

### Conclusion

Thus from the present investigation it could be concluded that for successful cultivation of cauliflower, micronutrient should spray at seedling stage (15 DAS) and 20 & 35 DAT for getting better growth. Micronutrients should applied @ Zn 1000 ppm + B 200 ppm + Mo 50 ppm for same.

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